Multi-Dimensional Assessment of Resource, Environment and Economy of Biomass Use - A Case Study of Firewood Use in Households in Nishiwaga -

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Multi-Dimensional Assessment of Resource, Environment and Economy of Biomass Use - A Case Study of Firewood Use in Households in Nishiwaga -

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Abstract

In this study, we propose a new assessment tool for woody resource projects. The tool includes estimation of the amount of available woody resource and matching of its supply and demand, and assessment of both environmental and economic performance as well. As a case study, we apply the tool to a project of firewood promotion in Nishiwaga, Japan. Using the tool, we estimate the amount of available woody resource and the transport cost of the resources by using Geographic Information System (GIS), and match its demand and supply by using linear programming, and finally calculate greenhouse gas (GHG) balance and economic impact both on a household and on local economy.

As a result, we found that only 36% of woody resource is actually available in Nishiwaga, and there is enough woody resource supply to cover its demand for firewood in Nishiwaga. However, we also found that when looking at each community, some communities will import woody resource from other communities in the town within next ten years even if they have enough available resource in their communities. This is because it is much cheaper to import than to supply domestically. In terms of environmental performance, the GHG reduction amounts to 1.9 CO_2-t per household per year. In the economic aspect, converting from kerosene to firewood increases money flow in the town and induces a positive economic impact on the local economy.

It would be thought that it is important to understand not resource potential but resource availability to ensure resource procurement and that it is also important to look at spatial constraint and transportation cost of resources as well as resource availability.

Introduction

In order to contribute to planning woody resource promotion policies, biomass utilization projects should assess not only its economicfeasibility but also its resource availability and environmental performance. It is important to estimate the amount of available resources for carrying out the projects. Without this assessment, the projects might be difficult in procuring resources, and their environmental and economic performance might not achieve their targets. There are a lot of studies about assessment of biomass projects from the viewpoints of resource availability, environment and economy. However, most of them are studied individually.

Therefore, in this study, we propose an assessment tool for woody resource project from multi-dimensional aspects of resource, environment and economy. As a case study, we apply this tool to a project of firewood promotion in Nishiwaga, Japan. Using this tool, we estimate the amount of available woody resource and the transport cost of the resources by using Geographic Information System (GIS), and match its demand and supply by using linear programming, and finally calculate the reduction amount of greenhouse gas (GHG) and economic impact both on a household and on local economy.

Study area

This study focuses on the project about the use of unused thinned wood as firewood at households in Nishiwaga in Iwate prefecture. Nishiwaga is located in the southwest of Iwate prefecture (Figure 1). There are 2,493 households and the population is 7,093 in 2010 (Nishiwaga-machi (2010)). The area of this town is 590 km^2, and 90% of this town is covered with forest.

Methods

In this study, the procedure includes the following five steps. At first, we estimate the available amount of firewood and supply cost of firewood per 1 m^3 by forest subcompartments, based on the forest registration and geographic information data. Second, we estimate the demand of firewood by each community

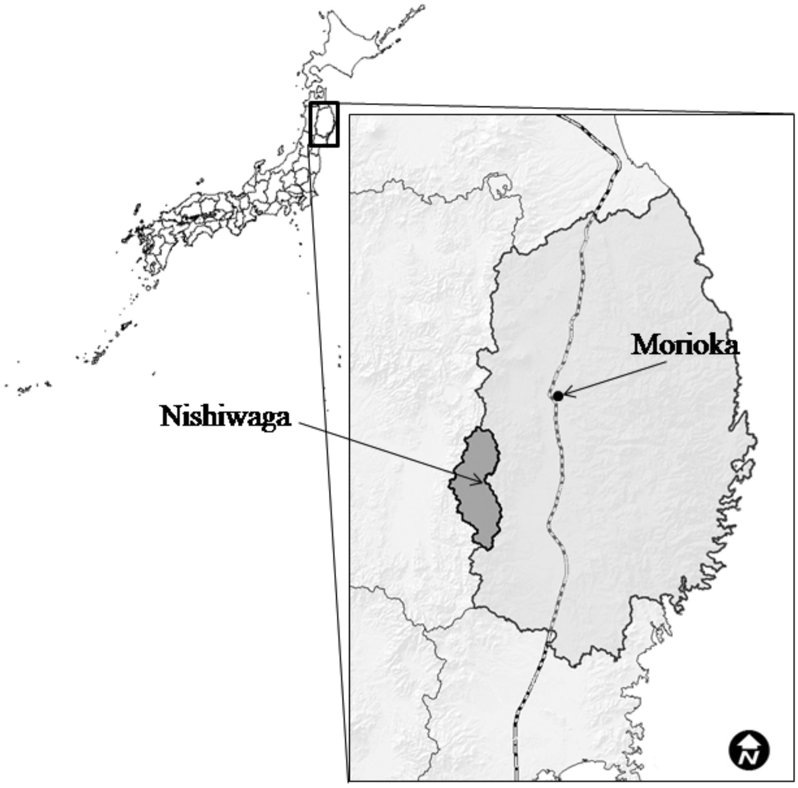

Figure 1. Location of Nishiwaga.

of Nishiwaga, from the statistics data of this town. Third, using the available amount data of firewood, the supply cost and the demand, we perform demand-supply matching by linear programing. We determine the carry-out amount of firewood to each community from each forest subcompartment. Then we compare the available amount and the carry-out amount of firewood. Fourth, we estimate the amount of GHG reduction. Finally, we evaluate the monetary flow in the town and economic effect on the surrounding area by means of Input-Output analysis.

In this analysis, we set the following assumption.

Evaluation of the resource: The households that use wood-burning stoves in Nishiwaga increase from 24.8% (613 households in 2006) to 50% (1,237 households in 2006) of total households, and all of wood-burning stove households from 2006 to use firewood from thinned wood of Japanese cedar. All these wood-burning stove users (1,287 households in 2006) are targets of our estimation.

Evaluation of environmental and economic impact: For negative impact on environment and economy due to the reduction of kerosene purchase cost, increased ratio of households (624 households) from 24.8% to 50% are the target of our estimation. For the positive impact on economy by the purchase of firewood, We target households that purchase firewood (242 households) . The target households are 38.9% of the increased number of households.

Results

Evaluation of resource

As a result of resource analysis with GIS, we confirm two things as follows. First, there are 10,081 subcompartments of Japanese cedar forest in Nishiwaga and its volume is 1.72 million m^3. On the other hand, the number of available forest subcompartments with the mean gradient of less than 35 degrees is 9,889 and the volume is 0.62 million m^3, 36 % of total abundance. There is a large difference between forest resource potential and its available amount as argued by Yoshioka et al. (2012). Therefore, it is important to clearly separate forest resource potential from its available amount. The available amount from the result of this analysis is more than 100 times of the annual demand (5,407 m^3) in this town.

Second, Figure 2 shows self-sufficiency of firewood after 10 years in each community. The self-

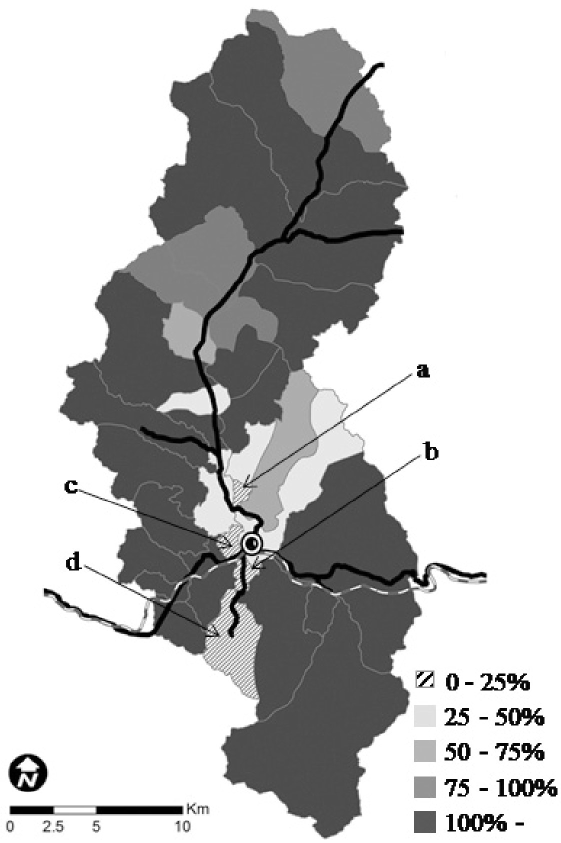

Figure 2. Self-sufficiency of firewood after 10 years in each community.
Note: Black lines are major roads, dashed line is a JR line, and double circle is location of the Yuda government office building.

sufficiency ratio is more than 75% in many communities but in some communities the ratio becomes less than 25% (the communities a, b, c, and d in Figure 2). Then, focusing on the communities with the self-sufficiency of less than 25%, we can recognize two types (Table 1) of community. One is the communities (a and b), where only small amount of firewood is available and they can cover the demand only for 4 to 6 years. This is because communities a and b are located in the center of the town, and the forest areas are small compared to the required amount of firewood. The other is communities (c and d). In these communities, the self-sufficiency ratio is extremely low although there is enough amount of firewood to cover the demand of the communities for more than 50 years.

We think that this is because extraction cost is higher than import cost from other communities.

These results imply that it is important to evaluate the use of woody resource with the premise of the available amount and, to match between the available amount and demand considering spatial distribution

Table 1. Self-sufficiency of firewood after 10 years in communities with the current self-sufficiency of less than 25%.

Community Name	Potential in the community (m^3)	Available amount (m^3)	Demand (m^3/year)	Duration (year)	Self-sufficiency in 10 years later (%)
a	5,554	2,006	338	5.9	1.2
b	2,547	867	222	3.9	0.4
c	24,777	8,949	144	62	7.7
d	39,019	14,192	55	258	12.6

and cost.

Evaluation of environmental impact

The amount of kerosene replaced with firewood by the increased number of households (624 households) is 475 kiloliters (762 liter per household). Based on our assumtion, we estimate that the reduction of GHG in the entire town is 1,183 t-CO_2 per year, and the reduction per household is 1.9 t-CO_2 per year.

Evaluation of economic impact

In terms of the impact on local economy, funds for kerosene that remain in the town are the only retail margin since all kerosene is imported. The retail margin is estimated at only 6.49 million yen whereas the kerosene sale is 39.3 million yen. For firewood, if all of 624 households (50% of households in the town) purchase firewood, the expense is 39.3 million yen, which is the same as kerosene expense. 61.1% of households procure firewood by themselves and 38.9% use funds to purchase firewood. Therefore, the expense and the funds that remain in the town are 15.3 million yen and 12.6 million yen respectively. Here we assume that 38.9% of households purchase firewood from the forest owners' association in Nishiwaga. There is a large difference between the funds of kerosene and firewood that remain in the town, even though the same amount of money is spent as the heating cost.

We calculate the induced increase of the product in the southern Iwate prefecture by using the Input-Output analysis. The net fund of the town is the increase of 6.05 million yen, because the funds for kerosene decrease to 6.49 million yen and the funds for firewood increases to 12.55 million yen (Figure3). Therefore, the induced production value is estimated

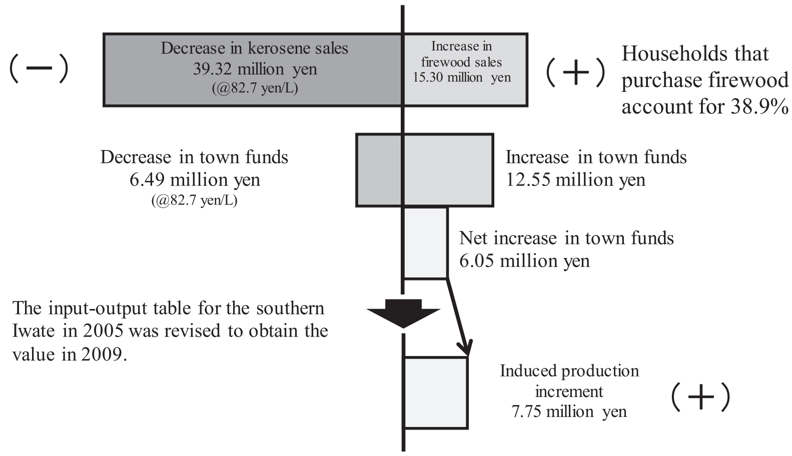

Figure 3. Induced economic impact by the usage of firewood in southern Iwate.

at 7.75 million yen. It is shown that the change of fuel from kerosene to firewood increases fund that remains in the town and produces a positive economic effect there.

Conclusion

From these results, we found that it is important to understand that not resource potential but resource availability ensures resource procurement, looking at spatial constraint and transportation cost of resources as well. All these aspects which are resource, environment and economy are considered by the tool proposed in this study. This tool can be applied not only to woody resource but also to other types of biomass for energy. We believe it can contribute to more practical policy making for local resource use.

References

Nishiwaga-machi, 2010. Statistics of Nishiwaga-machi (in Japanese).

YOSHIOKA, T. and Y. Suzuki. (2012) Unutilized resource amount of forest biomass, Journal of the Japan Forest Engineering Society, 27 (2): 111-117 (in Japanese).